

On August 28, 1859 a massive solar storm caused spectacular aurora seen all over the globe. It was reported in all the major newspapers; poems were written about it; and famous artists painted its shapes and forms. It also caused severe problems with telegraph networks at the time, which lasted for many hours worldwide. Although scientists gave detailed reports of the changing forms of this vivid display, many ordinary citizens offered their own impressions of this event too. Below are two of these descriptions seen from two different locations.

**Galveston, Texas:**

August 28 as early as twilight closed, the northern sky was reddish, and at times lighter than other portions of the heavens. At 7:30 PM a few streamers showed themselves. Soon the whole sky from Ursa Major to the zodiac in the east was occupied by the streams or spiral columns that rose from the horizon. Spread over the same extent was an exquisite roseate tint which faded and returned. Stately columns of light reaching up about 45 degrees above the horizon moved westward. There were frequent flashes of lightning along the whole extent of the aurora. At 9:00 PM the whole of the streaking had faded leaving only a sort of twilight over the northern sky.”

**London, England:**

“At 0:15 AM on August 28<sup>th</sup> the auroral light in the north assumed the form of a luminous arch, similar to daybreak, and in the southwest there was an intense glare of red covering a very large extent of the sky. At 00:20 AM streamers appeared; at 00:25 AM the streamers rose to the zenith and were tinged with crimson at their summits. At 00:45 AM frequent coruscations appeared in the aurora. At 01:20 AM the arch which had partially faded began to reform and the body of the light was very strong but not bright enough to read newspaper print. At 1:30 AM the light had begun to fade. By 2:00 AM the aurora was very indistinct.”

A common problem scientists face when organizing observations from different places around the world is that observers like to note when things happened by their local time. Scientists simplify these accounts by converting them into Universal Time, which is the local time in Greenwich, England, also called Greenwich Mean Time (GMT). To make time calculations easier, UT is expressed in the 24-hour clock format so that 11:00 AM is written as 11:00, but times after noon are written, for example, as 1:00 PM is written as 13:00, and 10:00 PM is written as 22:00. Since London is very close to Greenwich, the times mentioned in the London account above are already in Universal Time and only need to be converted to the 24-hour format. For Galveston, Texas, its time is 5 hours behind UT so that to get the equivalent UT for Galveston, first convert the Galveston times to the 24-hour format, then add 5 hours.

**Question 1** - From these two descriptions, can you extract the specific points of each narrative? What are their similarities?

**Question 2** - From the sequences of events in each description, can you create a timeline for the aurora display that fits the most details?

**Question 3** - Why was the aurora observed to reach closer to zenith in London than in Galveston?

**Question 1** - From these two descriptions, can you extract the specific points of each narrative? What are their similarities? **Answer:** Here are the main points in each story with the similarities highlighted.

Story 1:

1. Display began at end of twilight with faint **reddish light in north**.
2. 7:30 PM (00:00 UT) **streamers began to appear**
3. Streamers of spiral columns filled eastern sky
4. Faint rose-colored light covered same eastern sky, fading and returning
5. Columns of light reached **45 degrees to zenith**, and moved westwards
6. Frequent **flashes of light along the whole aurora**
7. 9:00 PM (02:00 UT), the **aurora faded** and left a twilight glow in north.

Story 2:

1. 00:15 AM (00:15 UT) - Luminous arch **appeared in northern** sky
2. 00:16 AM (00:16 UT) - Intense glare of red in southwest
3. 00:20 AM (00:20 UT) - **Streamers appeared**
4. 00:25 AM (00:25 UT) - Streamers **reached zenith** and were crimson at highest points
5. 00:45 AM (00:45 UT) - Frequent **coruscations appeared in aurora**
6. 01:20 AM (01:20 UT) - Arch begins to fade and reform
7. 01:30 AM (01:30 UT) - Aurora **begins to fade**.
8. 02:00 AM (02:00 UT) - Aurora very indistinct.

Similarities: Auroral light appeared in northern sky. Streamers appeared soon afterwards. The streamers expanded in the sky until they were nearly overhead from Galveston, and overhead in London. The aurora shapes showed activity in the form of flashes and movement (coruscations). Soon after this active phase, the aurora faded.

**Question 2** - From the sequences of events in each description, can you create a common timeline for the aurora display that fits the most details?

**Answer:** Each student might group the events differently because the eyewitness accounts are not detailed enough. Because this aurora is seen in the Northern Hemisphere, it is properly called the aurora borealis. Here is one way to organize the timeline:

“The aurora borealis started with a faint wash of reddish light in the north. A brilliant arch of light formed. Five minutes later, streamers began to appear which were crimson at their highest points above the horizon. Then, coruscations (waves) began to appear in the brightening red glow of the aurora with the streamers filling the entire eastern sky. The columns of light and streamers began to move westwards, and frequent flashes of light were seen along the aurora as the luminous arch of began to fade and reform. After an hour and fifteen minutes, the aurora began to fade away, leaving behind a twilight glow that persisted for another half-hour.”

**Question 3** - Why was the aurora observed to reach closer to zenith in London than in Galveston? **Answer-** Because the aurora is a polar phenomenon, and London is at a higher latitude than Galveston. That means that the aurora will be seen higher in the northern sky from London than from Galveston.